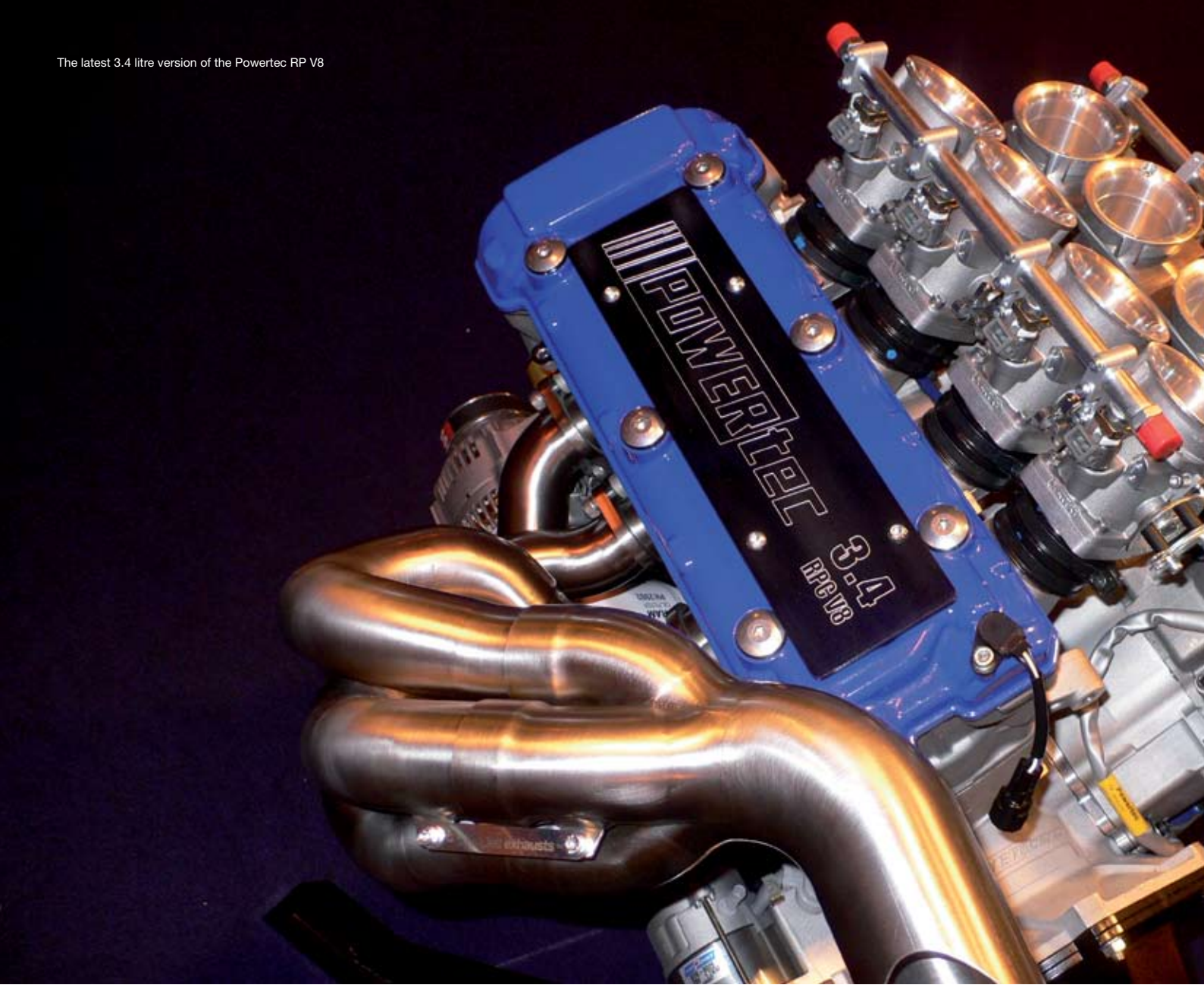


The latest 3.4 litre version of the Powertec RP V8

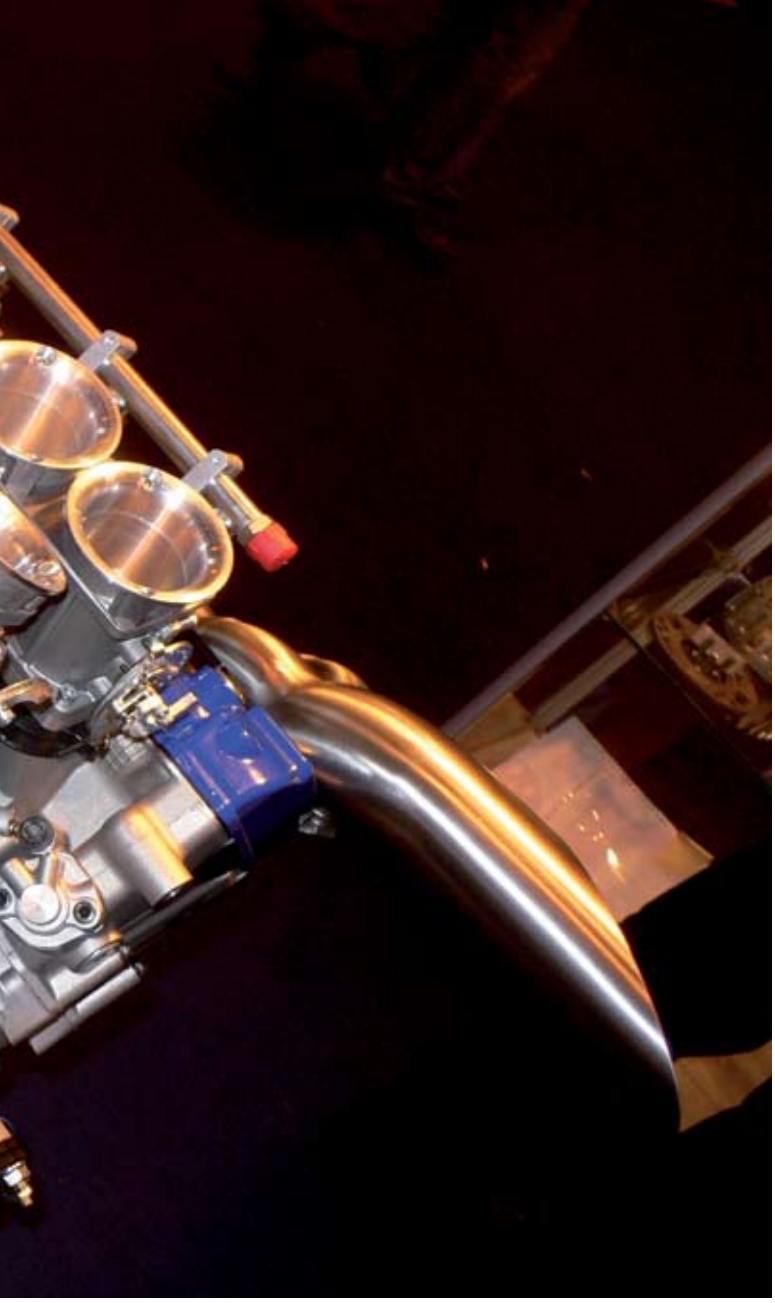
Doubled up

Tom Sharp investigates a cost effective V8 racing engine

Powertec Engineering's innovative, Suzuki Hayabusa-based RP V8 engine was introduced in the UK at the Autosport International show back in January 2005 since when it has been a resounding technical and commercial success. Founded upon a pair of 1.3 litre Hayabusa I4 motorcycle engines and having initially a 2.6 litre displacement, it had been commissioned by Radical Motorsport for installation into that company's SR8 sports-racing car. Radical specialised in motorcycle-engined sports-racers and was keen to augment its popular four cylinder machines with a V8.

The RP was designed and detailed by Steve Prentice of SPD Ltd on behalf of Powertec. It essentially consists of a pair of Hayabusa engines, arranged at a 72° bank angle, driving a common crankshaft and mounted to a dedicated dry-sumped crankcase. The result is a keenly priced V8 engine that is very light, powerful and reliable. The engine is now owned, manufactured and built by Powertec Engineering from its base in Peterborough, England. Run by former motorbike engine tuning specialist Ted Hurrell, Powertec employs 14 people in a 3000 sq ft factory.

The original 2.6 litre RPA and the subsequent 2.8 litre RPB have now been joined by three other varieties (see Table 1), which demonstrates just how much flexibility is in the base package. The numbers tell the story of commercial success well enough. Powertec have to date built a total of 110 RP engines (including 75 RPAs and 25 RPBs); volumes which any bespoke engine manufacturers would be proud of. However,



the RP series only represents 20% of Powertec's business; the majority revolves around building and tuning the Suzuki Hayabusa four cylinder engines for markets such as motorbike racing, low volume production cars, autograss racing and hill climbing.

In this article we will examine the structure of the RP V8 in more detail than ever before. We will look at how Powertec has handled development in terms of performance and reliability, and what issues were overcome in designing the long stroke version.

STANDARD STROKE RPA & RPB

The RP V8 started life as the RPA with the 81 mm bore and 63.0 mm stroke of its (up to) 2007 Suzuki Hayabusa donor giving 325 cc per cylinder for a total of 2597 cc. It is now available in a total of five different capacities (RPA/B/C/D/E) (Table 1), thanks to two crankshaft stroke options and three different bore options. Powertec even has a fourth bore option available (83 mm), which is used on some Powertec (four cylinder) Hayabusas, should any further variation be required.

One of the first steps from the RPA came in 2005 when Andy Horne commissioned Powertec to design and build a 2.5 litre version for use in a Metro 6R4 in the British Rally Championship. This was based on a short stroke crank and proved very successful; with a hatchback body to play with Powertec was able to find an extra 35 bhp by optimizing the inlet tracts and airbox. The engine ran into trouble with the MSA, which

RP V8 CAD image

governs UK motorsport – they banned it on the grounds of it not being derived from a passenger-carrying vehicle. Horne's solicitors eventually ensured the car received its required log book but the MSA made it clear that the RP was not welcome in rallying.

Powertec's original product portfolio plan had included a 2.0 litre 'screamer' version, but as Ted Hurrell explains customer demand drove the capacity in the opposite direction.

"The screamer was originally conceived for use in 2.0 litre hillclimb and VdeV sportscar racing, however the VdeV regulations quickly changed to insist upon four cylinder car engines and our hillclimb customers went in the direction of the unlimited classes, which means increasing swept volume as far as possible to maximize torque. So only one 2.0 litre engine was built before that variant was then unfortunately shelved.

"Those two examples, of the 2.5 and 2.0 litre engines go to illustrate how important it is to be able to react quickly to changes in sporting regulations and, for want of a better word, trends. If we had committed ourselves to a smaller capacity unit we would have been faced with significant re-engineering costs; as it was, the original design incorporated sufficient flexibility to allow us to switch our focus easily to larger capacity versions."

The 72° bank angle RP is founded upon a bespoke upper and lower crankcase, which are both cast in aluminium alloy. The bank angle was chosen purely for car installation reasons, as designer Steve Prentice ▶

Designation	RPA	RPB	RPC	RPD	RPE
Nominal Capacity	2.6 Litre	2.8 Litre	3.4 Litre	3.2 Litre	3.0 Litre
Bore, mm	81.0	84.0	86.0	84.0	81.0
Stroke, mm	63.0	63.0	71.5	71.5	71.5
Swept Volume, cc	2597	2793	3323	3170	2950

Table 1 – RP V8 Capacity Options


Trevor Willis in action in 2008 with 2.8 litre power


RP V8 installed in Willis' hillclimb car

SPECIFICATION

Powertec RPC 3.4 Litre
72 Degree V8
Bore 86 mm
Stroke 71.50 mm
Displacement 3323 cc
Naturally aspirated
102 octane racing fuel
Aluminium crankcase halves, cylinder barrels And heads
Integral liners
5 main bearings
Plain (shell) bearings
Steel crankshaft, 4 pins
Aluminium pistons, steel rings
Steel con rods
Double overhead camshafts
Duplex chain timing drive
4 valves, 1 plug per cylinder
28 degree included valve angle
34 mm intake valve
28.5 mm exhaust valve
Manifold injection
Distributorless ignition
Engine Management System
Compression ratio 11.0: 1 – 13.5 : 1
Maximum rpm 10,500

explains; "The priority was to make the engine as compact as possible; in the early concept design stages we were even looking at a transverse installation in the Radical SR8.

"We simply took both banks of cylinder barrels (i.e. the one piece monoblocks which the pistons run in) and reduced the bank angle until they were as close as was reasonably feasible. At the time a lot of Formula One engines were 72° V10s so people tend to assume that the bank angle is connected with that, or that it was specially chosen for engine balance reasons, but really if we could have made the engine even more compact with a 71° bank angle we would have!"

One consequence of this is that the engine does not fire evenly, with alternate intervals of 72° and 108° between firing pulses; Powertec haven't found this to be a problem and indeed customers report excellent traction, as Ted Hurrell explains: "The RP has a virtually perfect flat torque curve all the way from 4000 rpm; it's very responsive with no kicks in the curve. Trevor Willis was able to really exploit this in the British Hillclimb Championship, especially on tight tracks and in wet conditions."

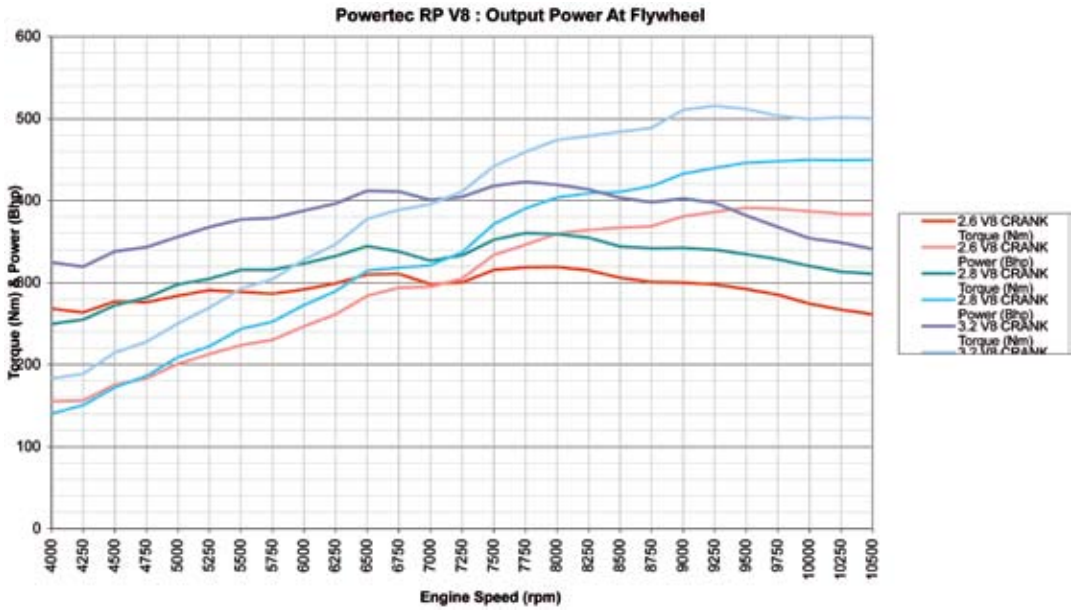
Indeed Willis is one of Powertec's most important customers. He finished third in the British Hillclimb Championship last year using a 2.8 litre RPB and for 2009 is switching to the new 3.4 litre RPC. *Race Engine Technology* asked Willis for his views on the RP.

"What you need as a hillclimb driver is more aligned with the needs of a rally driver than a circuit racer. With sometimes only six runs in a weekend, it's all about reacting to what you feel and see and to do so you need a predictable engine with a smooth torque curve. Engines which 'come on the cam' fiercely are a bit of a handful on the hills, which is why the Powertec V8 is perfect; it really delivers its power smoothly.

"We started racing the 2.6 litre in 2006, then switched to the 2.8 litre in 2007 and 2008; that gave us a noticeable step up in power while maintaining the drivability. For 2009 we're expecting another step up with the 3.4 litre.

"The only downside is a minor one; the RP can't be fully stressed, so we have to use a sub frame to take the chassis loads, which adds weight, but it's a price worth paying."

A fully stressed engine is one that forms the only structural link between the chassis tub and the transmission/ rear wing/ rear suspension. It is relatively common practice now in sports car design to run the engine semi-stressed; this is where in addition to the engine being rigidly fixed between the tub and the bellhousing, stiffening links are added between the tub ▶



POWERTEC RP V8 SUPPLIERS

Heads: Suzuki
Liners /bore coating: Suzuki
Monobloc Castings: Caress
Crankshaft: Arrow Precision
Camshafts: Suzuki/Kent
Timing Drive components: Suzuki, Drive Solutions
Tappets: Suzuki
Pistons: Suzuki, JE
Rings: Suzuki, JE
Piston pins: Suzuki, JE
Circlips: Suzuki, JE
Con rods: Suzuki, Arrow
Main & big end bearings: Suzuki, Mahle/Vandervell
Seals: Suzuki, Brammer
Fasteners: Suzuki, ARP, Unbrako, Northbridge, APE
Valves: Suzuki, REC
Valve seats & guides: Suzuki
Valve springs: Suzuki, APE
Cylinder head gasket: Suzuki, Cometic
Ignition system: Life Electronics
Fuel injectors: Magneti Marelli
Engine Management System: Life Electronics
Throttle: Jenvey
Water pump: Powertec
Oil pump: Powertec

and mounts on the bellhousing, typically running over the top of the engines' cam covers and under the sump.

The RP's upper crankcase is of an open deck design and at only 88.0 mm deck height it appears very low at first inspection; indeed as a finished component it weighs a mere 5.8 kg.

It incorporates the five main bearing panels, the upper half of the bellhousing and the piston cooling jet bosses, which are designed to take Hayabusa oil jets. The layout is arranged such that the left hand bank is set forwards with its timing drive at the front of the engine. The right hand bank is reversed, with its timing drive at the rear (bellhousing) end.

The lower crankcase weighs in at 6.9 kg. It incorporates five main bearing panels which create four fully compartmentalised crankcase chambers (although the scavenge outlets are deliberately linked). The scavenge outlets, filter mounts and pump mounts are located conventionally on the right hand side of the crankcase. At the front end is a chain/ gear case for the left hand bank timing drive and the pump gear drive, and there is a similar chain case at the rear for the right hand bank timing drive.

The oil filter, which is one of the few non-Hayabusa derived items on the engine, is mounted on the left hand side and feeds the main oil pressure gallery, which is located centrally on the underside. Alternator mounting bosses are provided at the front end and the rear end features the lower half of the bellhousing and starter mounting.

The RPA runs a conventional eight-counterweight single plane crankshaft and utilizes standard Hayabusa crankpin sizes. The crankshaft is manufactured by Arrow Precision in the UK and is a one piece steel item which is gas nitrided for fatigue strength. The rear timing gear is now incorporated into the crankshaft; the original design featured a separate gear which slid on from the back, but the restrictions which this placed on flywheel bolt design proved unacceptable.

Running a two-plane crankshaft would have prevented use of the Hayabusa cams and so was not considered; the use of a non-90° vee angle would have meant the out of balance forces not being cancelled anyway. The original crankshaft did, however, feature one disc counterweight with an external gear cut onto it to drive twin, twice engine speed balancer shafts, which were originally mounted on the left hand side of the engine, between the starter and the oil filter. Powertec had reliability problems with the bolts which attached the housings to the crankcase and deleted the balancer shaft assembly in 2005. Ted Hurrell explains: "When the engine was designed Steve Prentice incorporated the balancer shafts as we knew we could expect horizontal vibration forces from a single plane crankshaft V8. Unfortunately the balancer shafts and housing caused structural problems with the crankcases, and losses in power. Removing them showed no disadvantage so the crankcases were redesigned without the housing."

The original crankshaft was also cross-drilled, a feature that was designed in for manufacturing reasons. The engine suffered two failures early on in development, which were attributed to oil starvation at the crankpins, and as a result the oil feeds were redesigned as longitudinal drillings just underneath the surface of the journals, with consequentially lower oil pressure requirement, and the problem never recurred.

The original 2.6 litre engine uses Hayabusa connecting rods; the 2.8 litre uses standard length steel connecting rods manufactured by Arrow Precision. The piston is one area where Powertec can take advantage of the huge amount of work it does with four cylinder Hayabusa engines, and the large number of suppliers who make pistons for it.

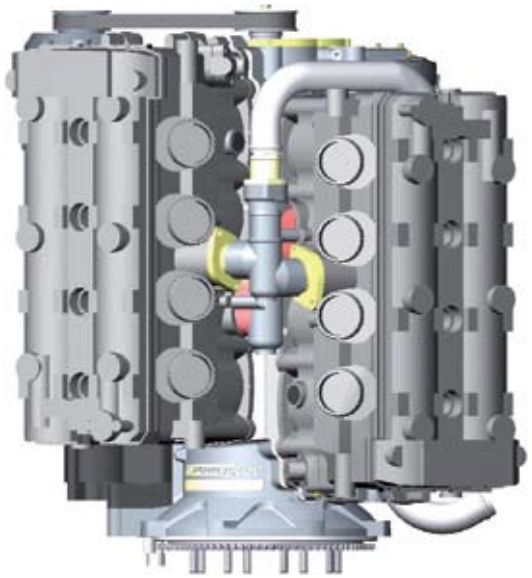
The pistons run in a Hayabusa 'monoblock' cylinder barrel; a one piece aluminium casting featuring four integral cylinder bores at 88 mm spacing with a chaincase at one end.

The standard 2.6 litre engine uses the 81 mm bore while the 2.8 litre uses an 84 mm bore (Powertec use 83 mm in its four cylinder engines).

A major breakthrough for Powertec for 2009 was sourcing a supplier of barrels with 86 mm bores. USA based Muzzy's produce this item in two pieces, which are then welded together. The larger bores are offset axially to maintain wall thickness between adjacent bores.

The cylinder head assemblies and head gaskets are entirely Hayabusa specification. Powertec produces the RPA in either 'stock' or 'tuned' specification. It uses the standard Suzuki camshafts and profiles on

RP V8 CAD overhead



THE HAYABUSA DONOR ENGINE

The 2008 Hayabusa features a number of key updates over the previous specification, as used for earlier RP engines. The 2008 cylinder head features titanium intake and exhaust valves with a valve angle of 14° and 'Twin Swirl' combustion chambers for increased combustion efficiency. Piston rings feature PVD ion plating for increased durability, reduced friction loss and reduced oil consumption. The crankcase gains ventilation holes at the cylinder skirt for reduced pumping losses and retains gear-driven balancer shafts for smooth operation.

The Suzuki SDTV fuel injection system is fitted with dual injectors per cylinder, whilst the S-DMS (Suzuki Drive Mode Selector) allows the rider to choose from three different engine maps.

MODEL YEAR	1999 - 2007	2008 ->	
Swept Volume	1299	1340	cc
Bore	81	81	mm
Stroke	63	65	mm
CR	11.0 : 1	12.5 : 1	
Torque	127	139	Nm
Power	171	197	bhp
Specific Power	131.6	147.0	bhp / litre

the 2.6 litre, but the 2.8 litre and above get bespoke inlet and exhaust profiles, which were designed in house by Powertec.

Two throttle arrangements are available. Customers can either specify a cast aluminium plenum with one throttle butterfly on each of the two inlets into the plenum, or an eight-throttle butterfly set up. The pump stack is located on the right hand side of the crankcase and is a bespoke design. It features six gerotor (duo-centric) pumps, two to generate oil pressure and four for crankcase scavenging. It is gear driven from the nose of the crankshaft via an idler gear. An impellor type water pump is mounted at the rear of the stack, taken from the original Suzuki engine.

The pumps have required limited development: the addition of extra bearing supports for the driveshaft and the adjustment of some machining tolerances mean they now produce excellent oil pressure and run reliably. Powertec also has a compliant pump drive in the pipeline but as such this is not part of the production specification.

THE LONG STROKE RPC, RPD & RPE

Converting the RP to long stroke was an essentially straightforward process, which started with some basic calculation and layout work. Powertec's initial target was to use the same stroke (71.5 mm) as its long stroke four cylinder engines, which would give a total swept volume of 3.2 litres with an 84 mm bore. The first step was to check crankcase clearance at that stroke. Steve Prentice had allowed generous clearances in the crankcase from the start of the project, so major problems were not anticipated. Nor were they found; all that was required in terms of crankcase modification was repositioning of the oil jets down one bank and some guarantee machining.

The long stroke crankshaft is similar to the original one but follows the practice of the existing long stroke four cylinder engines in that it features slightly larger crankpins to maintain stiffness and cope with the increased loads. The increased crankpin is sized to allow the use of readily available bearing shells.

The long stroke engines feature an 8 mm thick spacer plate between the upper crankcase and the monoblock (with cylinder barrels). This serves to keep the pistons clear of the crankshaft counterweights and the main bearing panels at BDC, as well as reducing the connecting rod angulation. Powertec resisted the temptation to locate the bottom of the cylinder bores in the spacer plate, instead retaining the standard practice of leaving them clear.

Increasing the rod angulation was a major concern in going to the long stroke version; trials were undertaken on a four cylinder engine using a 25 mm thick spacer plate and correspondingly long connecting rods in order to gauge the effect of reducing it. Powertec has not released the results of this test, but the fact that they have stayed with the 8 mm plate tells us that the benefits did not outweigh the costs. Ted Hurrell explains: "Spacer plates give us two major problems; they increase the overall height of the engine and they re-position the cylinder head based engine mounts. We effectively went with a design which slightly compromised rod angulation but made car installation significantly easier and cheaper."

The long stroke conversion is then finished off with longer studs and con; bespoke Arrow steel H-Beam items are again specified.

IN CONCLUSION

The RP was deliberately designed to use every component possible from the Suzuki Hayabusa donor engines and this must be borne in mind when judging it. It is a compactly packaged engine with a lot of scope for tuning built into it and can be considered a very wise investment on behalf of its owners. Of course the RP benefits greatly from the fact that the donor engine is a wonderful piece of engineering; all the more so in 2008 specification.

We obviously can't leave the RP without addressing the question of power figures. The RPA in stock specification runs at a compression ratio of 11.0: 1 and develops 380 bhp in eight-butterfly throttle specification (146 bhp/litre).

The RPB runs at 13.5: 1 in tuned specification and develops 450 bhp in eight-butterfly throttle specification (161 bhp/litre).

The RP has been a genuine worldwide sales success for Powertec; 110 units sold speaks for itself. It is beyond the scope of this article to go into details but suffice to say Powertec now has a rebuild facility in the States specifically to serve that market. One wonders how far this engine could go: it even has the displacement to form an LMP2 engine and under the 2011 regulations that becomes an LMP1! ■